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A Radar/Radiometer Instrument for Mapping Soil Moisture and Ocean Salinity

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1. INTRODUCTION

The RadSTAR instrument combines an L-band, digital beam-forming radar with an L-band synthetic aperture, thinned array (STAR) radiometer. The RadSTAR development will support NASA Earth science goals by developing a novel, L-band scatterometer/ radiometer that measures Earth surface bulk material properties (surface emissions and backscatter) as well as surface characteristics (backscatter).

Present, real aperture airborne L-Band active/passive measurement systems such as the JPL/PALS (Wilson, et al, 2000) provide excellent sampling characteristics, but have no scanning capabilities, and are extremely large; the huge JPL/PALS horn requires a the C-130 airborne platform, operated with the aft loading door open during flight operation. The approach used for the upcoming Aquarius ocean salinity mission or the proposed Hydros soil mission use real apertures with multiple fixed beams or scanning beams. For real aperture instruments, there is no upgrade path to scanning over a broad swath, except rotation of the whole aperture, which is an approach with obvious difficulties as aperture size increases. RadSTAR will provide polarimetric scatterometer and radiometer measurements over a wide swath, in a highly space-efficient configuration. The electronic scanning approaches provided through STAR technology and digital beam forming will enable the large L-band aperture to scan efficiently over a very wide swath.

RadSTAR technology development, which merges an interferometric radiometer with a digital beam forming scatterometer, is an important step in the path to space for an L-band scatterometer/radiometer. RadSTAR couples a patch array antenna with a 1.26 GHz digital beam forming radar scatterometer and a 1.4 GHz STAR radiometer to provide Earth surface backscatter and emission measurements in a compact, cross-track scanning instrument with no moving parts. This technology will provide the first L-band, emission and backscatter measurements in a compact aircraft instrument and will be ideally suited to large apertures, possibly at GEO, and could possibly be implemented on a swarm of micro-satellites. This instrument will have wide application for validation studies, and will have application for other microwave frequencies.

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2. SCIENCE GOALS

The RadSTAR instrument is designed to map soil moisture and ocean salinity, both important components of the water cycle. The instrument will also map sea ice density and thickness—an important factor in ocean-atmosphere heat exchange in polar regions.

Soil moisture is an important component of the water cycle; soil moisture measurements are necessary for understanding and predictions of vegetation and ecosystem health, and are strong factors in the prediction of regional precipitation on monthly to seasonal time scales. Measurement of soil moisture is based on observation of the microwave emission from the soil, which is a function of soil moisture and temperature. The measurements of soil moisture are required through the root zone, or down about 20 cm. Since soil penetration depth is proportional to wavelength, the longest practical wavelength, here L-band, is preferred. The L-band backscatter measurements measure soil and terrain roughness and biomass; additional components of the microwave emission. Evaluation of different components of the soil and biomass can therefore be provided through use of both backscatter and emission observations and through measurement of the polarization components of the signals.

Sea surface salinity measurements are also important aspects of the water cycle. When added to knowledge of oceanic precipitation, salinity provides the potential to estimating oceanic evaporation.